

U.S. Patent Application Serial No. 10/655,020
Response dated August 11, 2004
Reply to OA of May 18, 2004

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A refrigeration cycle apparatus using carbon dioxide as a refrigerant and having, comprising:

a compressor[[,]];
an outdoor heat exchanger[[,]];
an expander[[,]];
an indoor heat exchanger; [[and]]
an auxiliary compressor[[,]]; and
a plurality of four-way valves connecting said compressor, said outdoor heat exchanger, said expander, said indoor heat exchanger, and said auxiliary compressor,
in which wherein said auxiliary compressor is driven by power recover recovered by said expander, and

wherein when refrigerant flows using said indoor heat exchanger as an evaporator, a discharge side of said auxiliary compressor becomes a suction side of said compressor, and when

said plurality of four-way valves are switched over such that refrigerant flows using said indoor heat exchanger as a gas cooler, a discharge side of said compressor becomes a suction side of said auxiliary compressor.

Claim 2 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 1, further comprising wherein said plurality of four-way valves include a first four-way valve to which a discharge side pipe and a suction side pipe of said compressor are connected, a second four-way valve to which a discharge side pipe and a suction side pipe of said expander are connected, and a third four-way valve to which a discharge side pipe and a suction side pipe of said auxiliary compressor are connected, wherein when refrigerant flows using said indoor heat exchanger as the evaporator, the discharge side of said auxiliary compressor becomes the suction side of said compressor, and when refrigerant flows using said indoor heat exchanger as the gas cooler, the discharge side of said compressor becomes the suction side of said auxiliary compressor by said first four-way valve and said third four-way valve, and a direction of refrigerant flowing through said expander is always set in the same direction by said second four-way valve.

Claim 3 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 2, wherein at least one of said second four-way valve and said third four-way valve is replaced by a check valve bridge circuit comprising four check valves.

Claim 4 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 1, further comprising a bypass circuit which reduces an amount of refrigerant flowing into said expander, and a bypass valve which adjusts an amount of refrigerant flowing through said bypass circuit.

Claim 5 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 1, further comprising a pre-expansion valve which increases an amount of refrigerant flowing into said expander.

Claim 6 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 1, wherein a suction capacity of said compressor is set to 3 to 6 times of a suction capacity of said expander.

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Claim 7 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 1, wherein a suction capacity of said compressor is set to 4 times of a suction capacity of said expander, and a suction capacity of said auxiliary compressor is set to 4.3 times of the suction capacity of said expander.

Claim 8 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 1, wherein a cooling operation rated frequency of said compressor and a cooling operation rated frequency of said auxiliary compressor are the same frequency.

Claim 9 (currently amended): [[A]] refrigeration cycle apparatus according to claim 1, wherein an operation frequency of said auxiliary compressor is set lower than an operation frequency of said compressor.

Claim 10 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an indoor heat exchanger, in which said power ~~recover~~ recovered by said expander is used for driving

said compressor, wherein a sub-expander is provided in parallel to said expander, and an electric generator is connected to said sub-expander.

Claim 11 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an indoor heat exchanger, in which said power recover recovered by said expander is used for driving said compressor, wherein said expander is provided at its suction side with a sub-expander, and an electric generator is connected to said sub-expander.

Claim 12 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an indoor heat exchanger, in which said power recover recovered by said expander is used for driving said compressor, wherein said expander is provided at its discharge side with a sub-expander, and an electric generator is connected to said sub-expander.

Claim 13 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an

indoor heat exchanger, in which said power recover recovered by said expander is used for driving said compressor, wherein said expander is provided at its suction side with a first sub-expander, a second sub-expander is provided in parallel to said expander and said first sub-expander, and electric generators are connected to said first sub-expander and said second sub-expander, respectively.

Claim 14 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an indoor heat exchanger, in which said power recover recovered by said expander is used for driving said compressor, wherein said expander is provided at its suction side with a sub-expander, a bypass flow path is provided in parallel to said expander and said sub-expander, and said bypass flow path is provided with a bypass valve.

Claim 15 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an indoor heat exchanger, in which said power recover recovered by said expander is used for driving said compressor, wherein said expander is provided at its suction side with a pre-expansion valve,

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a sub-expander is provided in parallel to said expander and said pre-expansion valve, and an electric generator is connected to said sub-expander.

Claim 16 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an indoor heat exchanger, in which said power recover recovered by said expander is used for driving said compressor, wherein said expander is provided at its suction side with a first sub-expander, a second sub-expander is provided in parallel to said expander and said first sub-expander, an electric generator connected to said first sub-expander is an electric generator connected to said second sub-expander, and said electric generator includes a clutch mechanism which is connected to one of said first sub-expander and said second sub-expander.

Claim 17 (currently amended): [[A]] The refrigeration cycle apparatus using carbon dioxide as a refrigerant and having a compressor, an outdoor heat exchanger, an expander and an indoor heat exchanger, in which said power recover recovered by said expander is used for driving said compressor, wherein said expander is provided at its discharge side with a first sub-expander, a second expander is provided in parallel to said expander and said first sub-expander, an electric

generator connected to said first sub-expander is an electric generator connected to said second sub-expander, and said electric generator includes a clutch mechanism which is connected to one of said first sub-expander and said second sub-expander.

Claim 18 (currently amended): [[A]] The refrigeration cycle apparatus according to any one of claims 10 to 17, wherein the suction side of said compressor or the discharge side of said compressor is provided with said auxiliary compressor, and power ~~recover~~ recovered by said expander is used as power for driving said auxiliary compressor instead of said compressor.

Claim 19 (currently amended): [[A]] The refrigeration cycle apparatus according to any one of claims 10 to 17, further comprising a first four-way valve to which a discharge side pipe and a suction side pipe of said compressor are connected, and a second four-way valve to which discharge side pipes and suction side pipes of said expander and said sub-expander are connected, wherein refrigerant discharged from said compressor is selectively allowed to flow into said indoor heat exchanger or said outdoor heat exchanger by said first four-way valve, a direction of refrigerant flowing through said expander and said sub-expander is always set in the same direction by said second four-way valve.

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Claim 20 (currently amended): [[A]] The refrigeration cycle apparatus according to claim 18, further comprising a first four-way valve to which discharge side pipes and suction side pipes of said compressor and said auxiliary compressor are connected, and a second four-way valve to which discharge side pipes and suction side pipes of said expander and said sub-expander are connected, wherein refrigerant discharged from said compressor and said auxiliary compressor is selectively allowed to flow into said indoor heat exchanger or said outdoor heat exchanger by said first four-way valve, a direction of refrigerant flowing through said expander and said sub-expander is always set in the same direction by said second four-way valve.